A discussion of condensate removal systems for clarifier and thickener drives for water and wastewater facilities.

Richard L. Dornfeld, BSME, P.E.
Staff Engineer
Walker Process Equipment
Division of McNish Corporation
September 25, 2014

Moisture can be a problem for any enclosed drive including clarifier and thickener drives. Moisture in the drive may be the result of water infiltration or condensation or both.

Infiltration occurs when liquid water in the environment enters the drive housing. This can be the result of deteriorated seals, unusual weather such as hard driving rain or deep melting snow, or normal operations such as equipment wash down. Infiltration can usually be prevented, or at the very least greatly reduced by appropriate drive design along with reasonable routine maintenance.

Condensation occurs when the air temperature within the drive housing reaches the dew point. The dew point depends on the moisture carried by the air upon entering the housing at the outside air temperature. As moist air is cooled, the amount of water vapor that the air can carry is lowered. If the temperature reaches the moisture saturation point, some moisture will condense into liquid water from vapor. This is the dew point.

Condensation cannot usually be prevented as all clarifier and thickener drives exchange air with their surroundings. As these drives are often located outdoors, both the ambient air conditions and the effects of sun light and darkness greatly influence the amount of moisture in the air and the amount of air that circulates into and out of the drive. The location of the drive over a large basin of water ensures a source of moisture and high humidity.

Covered basins present different problems. Usually the variation in temperature during the day is reduced while the humidity of the air is increased. An additional potential problem is the gases that may be retained under the cover that are dissipated to the atmosphere in open basins. The gases can be carbon dioxide, hydrogen sulfide, or other toxic or corrosive gases.

Moisture within the drive housing from infiltration or condensation contaminates and degrades the lubricating oil and can also raise the level of the oil, as the oil usually floats on top of any accumulated water. Moisture causes deterioration of bearings and gears by changing the characteristics of the lubricating oil as well as increasing corrosion of both ferrous and non-ferrous metals in contact with the water. Also, acids are generated by chemical reactions of the water with the lubricating oil or with corrosive gases.

If air exchange between the drive housing and the atmosphere is impractical to stop, how can condensation be prevented from damaging the drive?

One way to prevent internal drive damage is to eliminate the moisture in the air entering the drive. This at first seems to be a reasonable approach. The moisture can be removed by chilling the air below the dew point before it enters the housing, see figure 1.

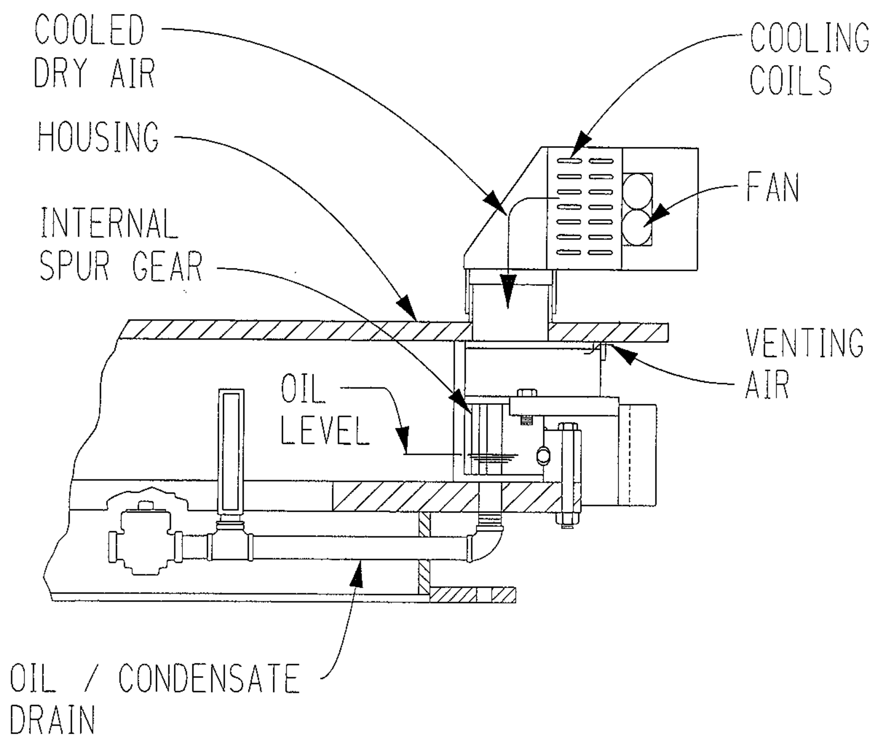

Figure 1
Air cooling system for moisture removal

This is the same principle that we use in air conditioning a home or business, or a pre-cooler or after-cooler in a process system. The problem lies in the varying temperatures of the ambient air surrounding the drive and the varying amounts of moisture the air carries at different times of the day or on different days in different weeks or months.

The chilled air method requires chilling coils or other cooling equipment, again similar to an air conditioner. Even cold air can carry moisture. In order to remove moisture from the air entering the gear housing, the air temperature must be lowered below the dew point of the air. In winter, this requires dropping the air temperature below the freezing point of water in some cases. Unfortunately, frost or ice accumulates on the cooling coils, which prevents the equipment from functioning properly. While a chilling system might work in some temperature ranges, it does not work over the temperature ranges associated with clarifier and thickener year round operation in most areas.

Another drawback is the power consumption of the refrigeration system and the air handling fan. Both of these items also require periodic maintenance, adding to the cost.

A less thought out attempt at preventing the formation of condensation is to heat the air as it enters the drive housing. This merely lowers the relative humidity of the air by raising the temperature of the air. The relative humidity returns to its original value as the air cools to its original temperature as no water is removed by this heating. The energy to heat the air is lost and the moisture remains to condense as the air cools further after entry into the housing.

If the heating unit were large enough and the housing had only a single entry point and a single exit point for air to flow through, it might be possible to heat the air to a high enough temperature so that it would pass through the housing before cooling to the dew point. Unfortunately, most clarifier drives are usually not sufficiently air tight due to the necessity for the turntable to rotate the collector mechanism precluding air tight sealing. Some heated air will purge from the housing immediately while some air will remain inside the housing and cool. Condensate will form when this air reaches the dew point of the water vapor, see figure 2.

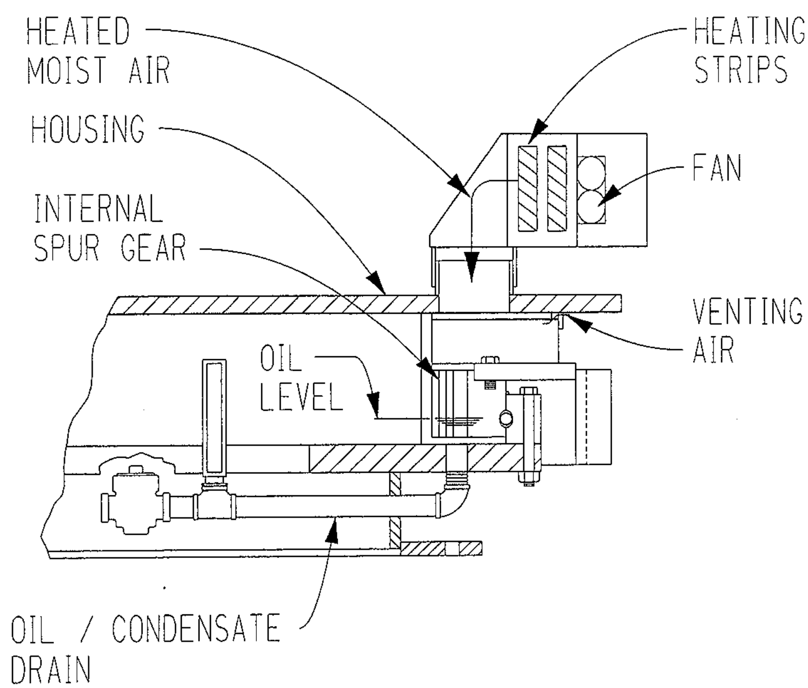

Figure 2
Ineffective air heating system

Pressurizing such a drive with warm air is difficult, as the air would follow the course of least resistance to reach ambient pressure and leak from the housing. There is even a potential for warmed air to leak from the housing and ambient air to leak into the housing at different locations and distances from the heating elements and fan. Short of surrounding the drive in an envelope of heated air, this system is doomed to fail at least part of the time if not most of the time.

The energy cost for the heat supplied and the fan to move the air as well as the cost of the equipment maintenance is wasted by this approach. It is understandable then that many of the drives with this type of condensate system also retain manual condensate drains.

Desiccant filters or packs are another method of removing some of the moisture from the air before it enters the drive. The use of desiccants has a problem eliminating the moisture in the air entering the housing due to the numerous air entry and exit points that by pass the desiccant.

Additionally, desiccants become saturated and must be replaced or regenerated. During the period when the desiccants are saturated, moisture is admitted into the housing in even greater quantities than when the desiccant is functioning. The replacement of the desiccant packs and regeneration of the packs, when possible, once again make this an expensive proposition for material and maintenance.

If it is difficult or impossible to prevent condensation from forming within the clarifier or thickener drive housing, how is the condensate to be handled to prevent deterioration or damage to the drive components and to prevent contamination and deterioration of the lubricant? One suitable answer is to remove the condensate as it is formed to limit the time that it can be in contact with the lubricant or drive components.

This requires the drive housing to be designed to efficiently separate condensate or infiltrate water from the lubricant and collect it at a housing low point. Many fabricated steel clarifier drives have flat bottoms which inhibits drainage when the drive is level. If the drive is slightly out of level the flat bottom forms a pocket the can retain condensate indefinitely. Such retained water at the oil to water interface is available to react with the lubricant over long periods of time.

The housing must be designed with a lubricant level sufficient to provide adequate lubrication of the drive gear teeth and bearings, but not an excessive high level as to unnecessarily extend the path of the condensate through the lubricant, increasing contact time between the water and the lubricant. Excessive lubricant levels can also lead to foaming which entraps water as well as air and holds both in suspension in the lubricant. When the water and air suspension reaches the gear tooth surfaces or other machined surfaces it accelerates corrosion above that of water alone.

Manual condensate drains remove the condensate and infiltrate periodically when the maintenance is preformed regularly. The problem occurs between regular condensate draining procedures. The accumulation of condensate will occur at different rates at different times of the year or even different times of the week. Condensate, if not removed as it accumulates, can build up, causing lubricating oil contamination and deterioration, which also reduces the lubricating properties of the oil. Condensate build up can cause erroneous oil level indication and corrosion of ferrous metal components in contact with the condensate. The manual condensate system must rely on the maintenance crew or plant operators to drain the water. Even in the best of times, the maintenance work load may preclude the completion of all maintenance tasks in a timely manner, if at all. In times of reduced budgets and manpower, this becomes an even less reliable alternative, see figure 3.

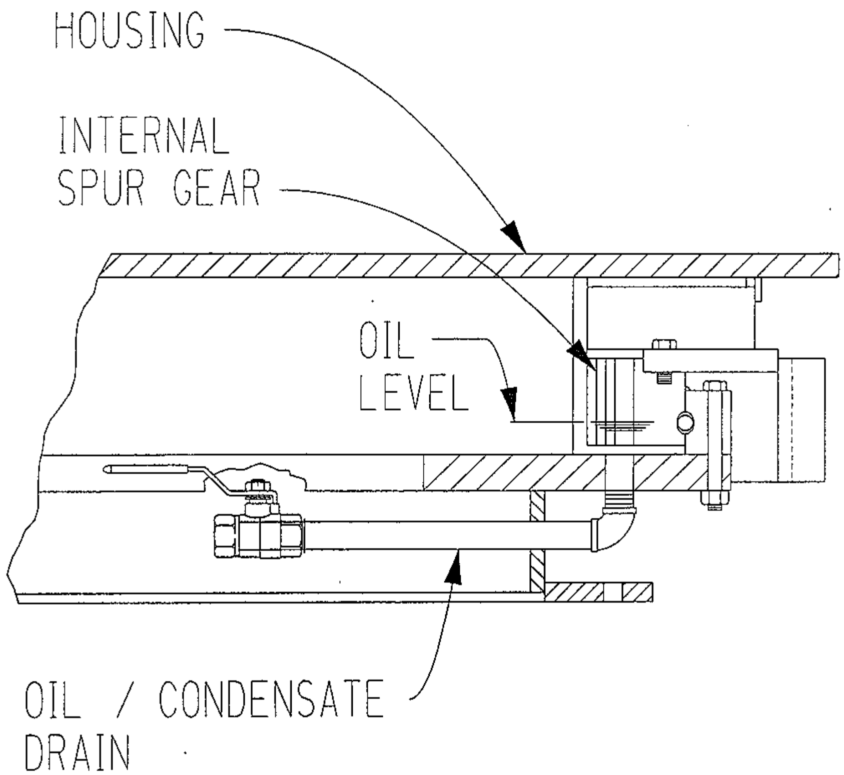

Figure 3
Manual condensate removal system

A siphon type automatic condensate system might drain the condensate from the housing under ideal conditions, but conditions are seldom ideal. In the summer, a dry period with low humidity will cause the water in the siphon to evaporate, reducing the standing column of water in the siphon necessary for proper operation. This can allow lubricant to be discharged from the system rather than water.

Another problem connected with the siphon type condensate system is the fixed dimensions of the siphon, or lack of adjustment to accommodate the different specific gravities of different lubricants. A siphon system that may work with one lubricant may fail when a different lubricant of higher or lower specific gravity is used either due to the seasonally required changes in lubricant or a change in lubricant brand, type, or vender, see figure 4.

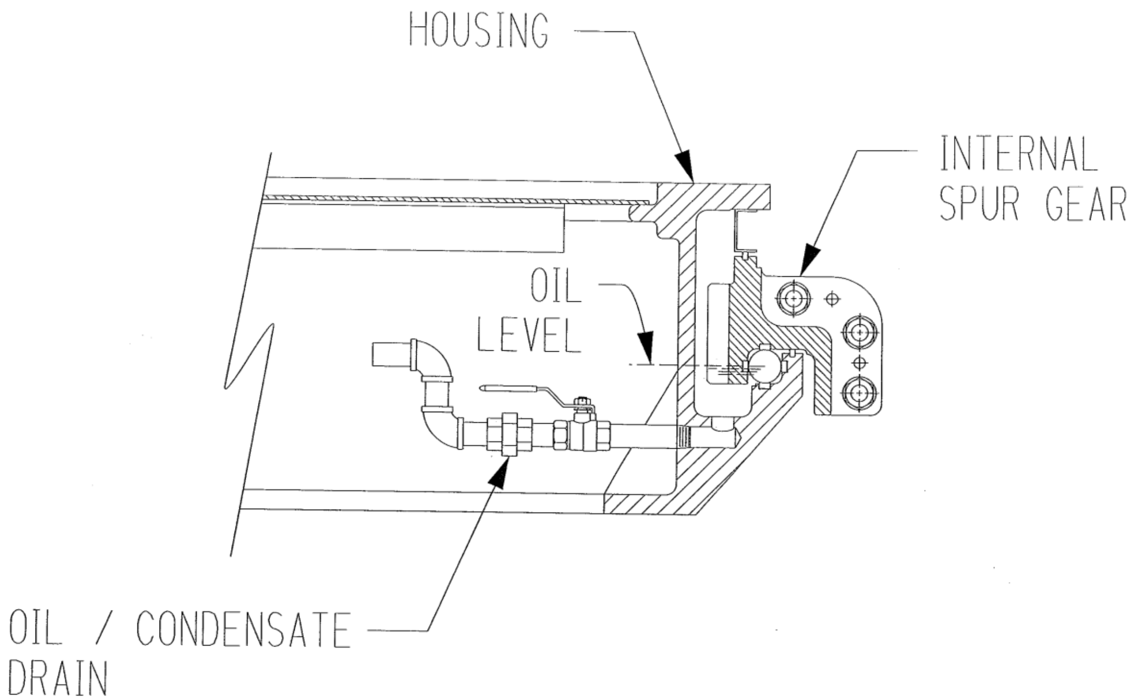

Figure 4
Siphon type condensate system

A solution to all of the above problems is an adjustable self acting siphon type condensation system that incorporates an automatic discharge check valve to prevent evaporation of the necessary standing water column. The system must also have an adjustable standing water column height to balance the weights of the columns of oils of different specific gravities. This system continuously removes any condensate as it reaches the lowest points of the housing. This is also true for any infiltrating liquid water. The self acting siphon or automatic condensate removal system, ACRS, is unaffected by evaporation and can adjust to match the specific gravity of the drive lubricating oil. The ACRS can be used with oils that shed water readily and do not absorb water readily, see figure 5 below.

In freezing conditions, the adjustable siphon condensate removal system requires heat trace tape and insulation, just as the older non-adjusting condensate system does. This is a common accessory in colder climates for most if not all manual and automatic condensate removal systems. The trace tape is not difficult or overly expensive to operate during the winter. This is also far superior to the addition of anti-freeze to the condensate system as the anti-freeze is diluted as the condensate is accumulated and discharged. Also, most lubricant manufacturers recommend against their lubricants coming in contact with anti-freeze and glycol in particular, which are considered a contaminant and could potentially cause oxidation and sludging of the oil.

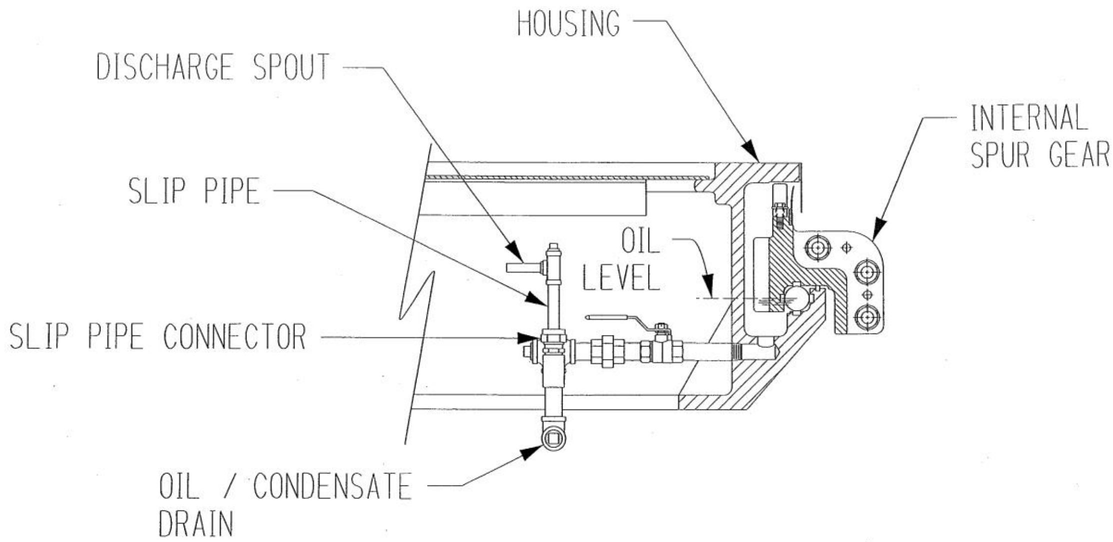

Figure 5
Automatic condensate removal system, ACRS

To summarize, we see that cooling or heating the air entering the drive housing is ineffective in preventing the formation of condensate and does nothing to treat infiltration. Manual condensate systems may be hit or miss in operation, and the older continuous siphon condensate systems have disadvantages that limit their effectiveness for removing condensate and infiltrating water.

Only an automatic condensate removal system reduces or eliminates the condensate problem in clarifier and thickener drives.

An automatic condensate removal system:

- Controls and maintains the appropriate column of water in all weather conditions.
- Can be adjusted to the specific gravities of different gear oils.
- Removes both condensate and infiltrated water from the drive housing on a continuous basis.